Case Docket No. 99P7471US01 02-23-00 **Date:** February 22, 2000 A

BOX PATENT APPLICATION
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Transmitted herewith for filing is a Patent Application of:

Inventor(s): Harald Lichtinger, Ralf Oestreicher and Josef Dirmeyer

For : METHOD AND APPARATUS FOR SENSING SEAT OCCUPANT WEIGHT

Enclosed are:

X	18 Page patent application.
X	3 Sheets of drawings -- X Formal, ___ Informal
X	An Assignment of the invention to Siemens Automotive Corporation
X	A Combined Declaration and Power of Attorney.
____	A Verified Statement By Assignee Claiming Small Entity Status
____	An Associate Power of Attorney
____	A Preliminary Amendment.
____	Information Disclosure Statement and PTO Form 1449 with copies of cited patents

The filing fee has been calculated as shown below:

	No. Filed	No. Extra	Small Entity		Large Entity	
Basic Fee						$ 690.00
Total Claims	18-20	-0-	@ $ 9	-0-	@ $ 18.00	-0-
Indep. Claims	3-3	-0-	@ 39	-0-	@ $ 78.00	-0-
Multiple Depend. Claim(s) Present -0-			$ 260.00			
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X Any additional filing fees required under 37 CFR § 1.16.

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Respectfully Submitted,

HOWARD & HOWARD

Kerrie A. Laba, Registration No. 42,777
The Pinehurst Office Center
1400 North Woodward Avenue, Suite 101
Bloomfield Hills, MI 48304-2855
(248) 645-1483

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METHOD AND APPARATUS FOR SENSING SEAT OCCUPANT WEIGHT

RELATED APPLICATION

This application claims priority to provisional application 60/120,637 filed on February 24, 1999.

BACKGROUND OF THE INVENTION

1. Field of the Invention.

This invention relates to a method and apparatus for measuring the weight of a seat occupant. Specifically, a sensor arrangement is mounted within a vehicle seat track to provide accurate seat occupant weight measurements.

2. Related Art.

Most vehicles include airbags and seatbelt restraint systems that work together to protect the driver and passengers from experiencing serious injuries due to a high speed collision. It is important to control the deployment force of the airbags and the force of the seatbelt pretensioners based on the size of the driver or the passenger. One way to control these forces is to monitor the weight of the seat occupant. If a smaller person such as a child or infant in a car seat is in the passenger seat, the weight on the seat will be less than if an adult occupies the seat.

Current systems for measuring the weight of a seat occupant are complex and expensive. One type of system uses pressure sensitive foil mats mounted within the seat bottom foam. Another system uses sensors placed at a plurality of locations

within the seat bottom. The combined output from the mats or the sensors is used to determine the weight of the seat occupant. These sensors experience a substantially vertical force, due to the weight of the seat occupant, but are also subject to longitudinal and lateral forces caused by acceleration, deceleration, or turning. The lateral and longitudinal forces picked up by the sensor incorporate an error component into the weight measurement. The sensors are very sophisticated using multiple strain gages and complicated bending elements to provide high measurement sensitivity in the vertical direction and low sensitivity to lateral and longitudinal forces in order to increase accuracy.

Mounting these sensors within the seat bottom can also be difficult and time consuming. It is difficult to find mounting locations for each the sensors that will accommodate all of the various positions of a seated occupant while still providing accurate measurements. Further, shifting of the occupant on the seat can dislodge or move the sensors out of their proper location. Because the sensors are mounted within the seat bottom, it is difficult to reposition the sensors after the seat is installed in the vehicle.

Thus, it is desirable to have a simplified seat occupant weight measurement system that is accurate and easily to install and overcomes the above references deficiencies with prior art systems.

SUMMARY OF THE INVENTION

In a disclosed embodiment of this invention, a system for measuring the weight

of an occupant seated on a vehicle seat includes a track assembly that is used to support a vehicle seat. The track assembly includes a first track mounted to a vehicle structure and a second track supported for movement relative to the first track. The tracks are deflectable in a vertical direction due to an occupant weight force exerted on the seat. At least one sensor is mounted on the tracks for generating a signal representative of the occupant weight force.

In a preferred embodiment, the track assembly is comprised of an inboard track assembly and an outboard track assembly spaced apart from the inboard track assembly. A first sensor assembly is mounted to the inboard track assembly for generating a first signal in response to measuring deflection of the inboard track assembly due to seat occupant weight. A second sensor assembly is mounted to the outboard track assembly for generating a second signal in response to measuring deflection of the outboard track assembly due to seat occupant weight. The system uses a central processor to determine seat occupant weight based on the first and second signals. The system also preferably includes an airbag control module that is in communication with the processor. Deployment force of an airbag is controlled by the control module based on seat occupant weight.

A method for determining the weight of a seat occupant includes the following steps. An inboard seat track assembly is mounted to a vehicle structure and an outboard seat track assembly is spaced apart from the inboard seat track assembly and mounted to the vehicle structure. The inboard and outboard seat track assemblies are defined by a predetermined cross-sectional area and each track assembly has at least

one track segment with a cross-sectional area that is less than the predetermined cross-sectional area. The method steps includes mounting a first sensor assembly in the track segment of the inboard seat track assembly, mounting a second sensor assembly in the track segment of the outboard seat track assembly, generating a first signal from the first sensor assembly in response to deflection of the inboard track assembly due to seat occupant weight, generating a second signal from the second sensor assembly in response to deflection of the outboard track assembly due to seat occupant weight, and combining the first and second signals to determine seat occupant weight.

Additional steps include providing a system controller for controlling deployment of an airbag and generating a seat occupant weight signal based on the combination of the first and second signal. The seat occupant weight signal is transmitted to the controller and the deployment force of the airbag is controlled based on the seat occupant weight.

These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view showing a vehicle with an airbag system and an occupant sitting in a seat with the airbag in an active state shown in dashed lines.

Figure 2 is a side view of a seat assembly incorporating the subject weight measurement system.

Figure 3 is a side view of the seat track assembly of Figure 2.

Figure 3A is a magnified view of the section 3A indicated in Figure 3.

Figure 4 is a cross sectional view of the track assembly taken along lines 4-4 of Figure 3.

Figure 5 is a schematic view of a control system for the subject weight measurement system.

Figure 6 is a schematic view of the sensors mounted within the subject track assembly.

Figure 7 is a schematic view representing a full bending bridge.

Figure 8 is a schematic view of the sensors mounted within the subject track assembly having an overload mechanism.

DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

A vehicle includes a vehicle seat assembly, shown generally at 12 in Figure 1, and an airbag system 14. The seat assembly 12 can be either a driver or passenger seat and includes a seat back 16 and a seat bottom 18. When a vehicle occupant 20 is seated on the seat 12 a vertical force Fv is exerted against the seat bottom 18. The vertical force Fv represents the weight of the seat occupant 20.

The airbag system 14 deploys an airbag 24 under certain collision conditions. The deployment force for the airbag 24, shown in dashed lines in Figure 1, varies according to the weight of the occupant 20. The vehicle includes a unique system for measuring the weight of the seat occupant 20. This unique system is installed within a seat track assembly, generally indicated at 26 in Figure 2.

The seat track assembly 26 includes a first track member 28 mounted to a vehicle structure 30 such as a floor, frame, or riser, for example. A second track member 32 is supported for movement relative to the first track member 28 along a longitudinal axis 34. First 38 and second sensors 40 are mounted on one of the track members 28, 32. The sensors 38 and 40 are used to generate a signal representative of the occupant weight. The first sensor 38 is preferably positioned rearwardly and the second sensor 40 positioned forwardly on the track assembly 26. The first 38 and second 40 sensors are used to measure deflection of the track assembly 26 to generate the signal.

The first track member 28 includes a forward end 42 and a rearward end 44 with a central track portion 46 extending between the ends 42, 44. The forward 42 and rearward 44 ends are mounted to the vehicle structure 30 such that the central track portion 46 remains unsupported to form gap 48 between the vehicle structure 30 and the central track portion 46. Preferably, the first track member 28 is mounted to a riser 50 having upwardly extending supports 52 at each end for attachment to the forward 42 and rearward 44 ends of the first track member 28.

Thus, the central track portion 46 of the seat track assembly 26 is deflectable under load. When the occupant is seated on the seat 12, a vertical force Fv is exerted against the track assembly 26, as shown in Figure 3. Reaction forces Fr are exerted in the opposite direction. The forces cause the central track portion 46 to deflect and reflect full bending beam behavior, shown generally at 54 in Figure 3A. The sensors are preferably strain gages 38, 40 that are positioned along the central track portion 46,

however, other types of sensors known in the art could also be used. For example, fiber optic or magneto elastic sensors could be used.

The sensors 38, 40 are preferably positioned in the first track member 28 such that the sensors 38, 40 remain positioned in the unsupported track section as the second track member 32 adjusts horizontally along axis 34. As shown in Figure 4, a plurality of ball bearings 56 are installed between the track members 28, 32 such that the second track member 32 can slide easily relative to the first track member 28. The bearings 56 also transfer the forces applied to the second track member 32 to the rigid track portion 46 between the two (2) sensor locations.

As shown in Figure 5, the seat 12 is mounted to the vehicle structure 30 on an inboard track assembly 26a and an outboard track assembly 26b that is spaced apart from the inboard track assembly 26a by a predetermined distance. The inboard 26a and outboard 26b track assemblies are mounted to have similar bending behavior, i.e. both track assemblies 26a, 26b are deflectable in a vertical direction due to an occupant weight force. Both the inboard 26a and outboard 26b track assemblies include first 28 and second 32 track members.

In one embodiment, first 28 and second 32 sensors are installed in the inboard track assembly 26a and third 58 and fourth 60 sensors are installed in the outboard track assembly 26b. The first 38 and second 40 sensors generate a first signal 62 representative of the portion of occupant weight on the inboard track assembly 26a and the third 58 and fourth 60 sensors generate a second signal 64 representative of the portion of occupant weight on the outboard track assembly 26b. The signals 62, 64 are

transmitted to an electronic control unit (ECU) 66, which combines the signals to determine the weight of the occupant 20. The ECU then sends a control signal 68 to a system controller 70. Preferably, the system controller 70 is an airbag control module that is in communication with the ECU 66 such that the deployment force of the airbag 24 is controlled based on seat occupant weight. The system controller 70 could also be used to control the force of seat belt pretensioners based on occupant weight.

While the above configuration is preferred, an option configuration could utilize one sensor assembly mounted to the inboard track assembly for generating the first signal 62 in response to measuring deflection of the inboard track assembly 26a due to seat occupant weight and a second sensor assembly mounted to the outboard track assembly 26b for generating the second 64 signal in response to measuring deflection of the outboard track assembly 26b due to seat occupant weight.

As shown in greater detail in Figures 6, the track assembly 26 has a predetermined cross-sectional area defined by height H1. A portion, generally indicated at 72, of each track assembly 26 has a cross-sectional area defined by H2 that is less than the predetermined cross-sectional area H1. Each track assembly 26a, 26b has two (2) track portions 72 with this decreased cross-sectional area. One sensor assembly 38, 40, 58, 60 is mounted in each track portion 72. Only the first sensor assembly 38 is shown in Figure 6. As the track assembly 26 deflects under load, the sensor assembly 38 measures full bending beam behavior 54, shown in Figure 7. Each of the sensors 38, 40, 58, 60 at the four (4) locations thus serves as a Wheatstone

Bridge for measuring deflection. The operation of a Wheatstone Bridge is well known in the art.

Preferably, the reduced cross-sectional area track portions 72 are created by forming square shaped holes within the first track member 28. The holes create dual-beam spring elements. With such elements located on the inboard 26a and outboard 26b track assemblies, it is possible to measure the vertical force Fv applied on the area between the two sets of tracks 26a, 26b.

The method for determining the weight of a seat occupant includes the following steps. An inboard seat track assembly 26a is mounted to a vehicle structure 30 and an outboard seat track assembly 26b is spaced apart from the inboard seat track assembly 26a and mounted to the vehicle structure 30. The inboard 26a and outboard 26b seat track assemblies are defined by a predetermined cross-sectional area H1 and each track assembly 26a, 26b has at least one track segment 72 with a cross-sectional area H2 that is less than the predetermined cross-sectional area H1. The method steps include mounting a first sensor assembly in the track segment 72 of the inboard seat track assembly 26a and mounting a second sensor assembly in the track segment 72 of the outboard seat track assembly 26b. A first signal 62 is generated from the first sensor assembly in response to deflection of the inboard track assembly 26a due to seat occupant weight. A second signal 64 is generated from the second sensor assembly in response to deflection of the outboard track assembly 26b due to seat occupant weight. The first 62 and second 64 signals are used to determine seat occupant weight.

Additional steps include providing a system controller 70 for controlling

deployment of an airbag 24 and generating a seat occupant weight signal 68 based on the combination of the first 62 and second 64 signals. The seat occupant weight signal is transmitted to the controller and the deployment force of the airbag is controlled based on the seat occupant weight.

Other steps include providing the inboard 26a and outboard 26b track assemblies with forward ends 42 and rearward 44 ends interconnected by a center portion 46 and fixing the forward 42 and rearward 44 ends to a vehicle structure 30 such that the center portion 46 of each track assembly 26a, 26b remains unsupported. The track segment 72 is preferably located in the center portion 46.

As discussed above, the first sensor assembly is preferably comprised of first 38 and second 40 sensors that are mounted in the first track member 28 of the inboard track assembly 26a. The second sensor assembly is preferably comprised of third 58 and fourth 60 sensors that are mounted in the first track member 28 of the outboard track assembly 26b.

A seat track assembly 26 with integrated weight sensors 38, 40, 58, 60 is provided to determine the weight of an occupant 20 seated on a vehicle seat 12. It is preferable to integrate the sensors 38, 40, 58, 60 into the seat track assembly 26 because it is a common component for most vehicle seats 12. The subject weight measurement system is easily incorporated into any type of seat track configuration. The weight sensors 38, 40, 58, 60 are mounted within reduced size track segments 72 to measure deflection of the track material caused by the weight of the occupant 72. The measured weight is independent of seat positions and is accurately provided

in various occupant positions on the seat 12.

By measuring the deflection in all four (4) locations in the inboard 26a and outboard 26b track assemblies, it is possible to calculate the occupant weight, which is proportional to the sum of the output of all of the sensors 38, 40, 58, 60. The center of gravity of the upper part of the seat and the occupant can be calculated by subtracting the sum of the sensor signals in the front from the sum of the sensor signals in the rear and dividing the result by the sum of all four (4) signals. The electronics for signal conditioning can be housed within the track assemblies 26a, 26b as is well known in the art.

Under high overload conditions, the track assembly 26 experiences high vertical Fv and horizontal Fh forces. These forces cause the track to experience an overload resultant force Fre that will try to separate the track 26 from the floor 30. In applications, with heavy overload conditions, like seats having integrated or all-belts-to seat configurations, it is beneficial to integrate an active overload protection. One such method of protection utilizes an overload bolt 74, shown in Figure 8, extending through the track members 28, 30 to the vehicle floor 30. Under high vehicle impact forces, the bolt 74 prevents the track assembly 26 from separating from the floor 30. Thus, the reduced cross-sectional areas 72 do not have to sustain the full impact forces.

Although a preferred embodiment of this invention has been disclosed, it should be understood that a worker of ordinary skill in the art would recognize many modifications come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

CLAIMS

I claim:

1. A system for measuring the weight of an occupant seated on a vehicle seat comprising:

a first track mounted to a vehicle structure;

a second track supported for movement relative to said first track and being deflectable in a vertical direction due to an occupant weight force; and

at least one sensor mounted on one of said tracks for generating a signal representative of said occupant weight force.

2. A system according to claim 1 including a central processor for receiving said signal.

3. A system according to claim 2 including an airbag control module in communication with said processor wherein deployment force of an airbag is controlled by said control module based on seat occupant weight.

4. A system according to claim 3 wherein said first track includes a forward end and a rearward end with a central track portion extending between said ends, said forward and rearward ends being mounted to the vehicle structure such that said central track portion remains unsupported to form gap between the vehicle structure and the central track portion.

5. A system according to claim 4 wherein said sensor is positioned along said central track portion.

6. A system according to claim 5 wherein said at least one sensor is comprised of a first sensor positioned forwardly on said central track portion and a second sensor positioned rearwardly on said central track portion, said first and second sensors for measuring deflection of said second track to generate said signal.

7. A system according to claim 6 including a third track mounted to a vehicle structure, a fourth track supported for movement relative to said third track and being deflectable in a vertical direction due to an occupant weight force, and a third sensor mounted on one of said third or fourth tracks working with said first and second sensors to generate said signal, said first second tracks forming an inboard track assembly and said third and fourth tracks forming an outboard track assembly.

8. A system for measuring the weight of an occupant seated on a vehicle seat comprising:

an inboard track assembly mounted to a vehicle structure;

an outboard track assembly spaced apart from said inboard track assembly and mounted to the vehicle structure;

a first sensor assembly mounted to said inboard track assembly for generating a first signal in response to measuring deflection of said inboard track assembly due to seat occupant weight;

a second sensor assembly mounted to said outboard track assembly for generating a second signal in response to measuring deflection of said outboard track assembly due to seat occupant weight; and

a central processor for determining seat occupant weight based on said first and second signals.

9. A system according to claim 8 wherein said inboard and outboard track assemblies have a predetermined cross-sectional area with each track assembly having at least one track portion having a cross-sectional area that is less than said predetermined cross-sectional area, said first and second sensor assemblies being mounted on said track portion.

10. A system according to claim 9 wherein said inboard and outboard track assemblies each include a forward end and a rearward end with a central portion extending between said ends, said ends being mounted to the vehicle structure such that said central portions are unsupported forming a gap between the vehicle structure and the track assemblies.

11. A system according to claim 10 wherein said track portion having a cross-sectional area that is less than said predetermined cross-sectional area is located in said central portion.

12. A system according to claim 10 wherein said at least one track portion of each of said track assemblies is comprised of a first track portion located forwardly in said central portion and a second track portion located rearwardly in said central portion and wherein said first and second sensor assemblies each include a first sensor mounted on said first track portion and a second sensor mounted on said second track portion.

13. A system according to claim 10 including an airbag control module in communication with said processor wherein deployment force of an airbag is controlled by said control module based on seat occupant weight.

14. A method for determining the weight of a seat occupant comprising the steps of:

providing an inboard seat track assembly mounted to a vehicle structure and an outboard seat track assembly spaced apart from the inboard seat track assembly and mounted to the vehicle structure where the inboard and outboard seat track assemblies are defined by a predetermined cross-sectional area and each track assembly has at least one track segment with a cross-sectional area that is less than the predetermined cross-sectional area;

mounting a first sensor assembly in the track segment of the inboard seat track assembly;

mounting a second sensor assembly in the track segment of the outboard seat track assembly;

generating a first signal from the first sensor assembly in response to deflection of the inboard track assembly due to seat occupant weight;

generating a second signal from the second sensor assembly in response to deflection of the outboard track assembly due to seat occupant weight; and

combining the first and second signals to determine seat occupant weight.

15. A method according to claim 14 including the step of providing a system controller for controlling deployment of an airbag; generating a seat occupant weight signal based on the combination of the first and second signal; transmitting the seat occupant weight signal to the controller; and controlling a deployment force of the

airbag based on the seat occupant weight.

16. A method according to claim 14 including the steps of providing the inboard and outboard track assemblies with forward ends and rearward ends interconnected by a center portion and fixing the forward and rearward ends to a vehicle structure such that the center portion of each track assembly remains unsupported.

17. A method according to claim 16 including the step of locating the track segment in the center portion.

18. A method according to claim 14 wherein the first sensor assembly is comprised of a first sensor mounted rearwardly within the inboard seat track assembly and a second sensor mounted forwardly within the inboard seat track assembly and wherein the second sensor assembly is comprised of a third sensor mounted rearwardly within the outboard track assembly and a fourth sensor mounted forwardly within the outboard track assembly.

ABSTRACT OF THE INVENTION

A system for measuring the weight of a seat occupant is used to control airbag deployment. The system is incorporated into a vehicle seat supported on inboard and outboard track assemblies. The inboard and outboard track assemblies are mounted to a vehicle structure such that a center track portion remains unsupported. A first sensor assembly is mounted to the inboard track assembly and a second sensor assembly is mounted to the outboard track assembly. The first sensor assembly generates a first signal in response to measuring deflection of the inboard track assembly due to seat occupant weight. The second sensor assembly generates a second signal in response to measuring deflection of the outboard track assembly due to seat occupant weight. A central processor determines seat occupant weight based on the first and second signals. The central processor communicates with the airbag system to control the deployment of the airbag based on seat occupant weight.

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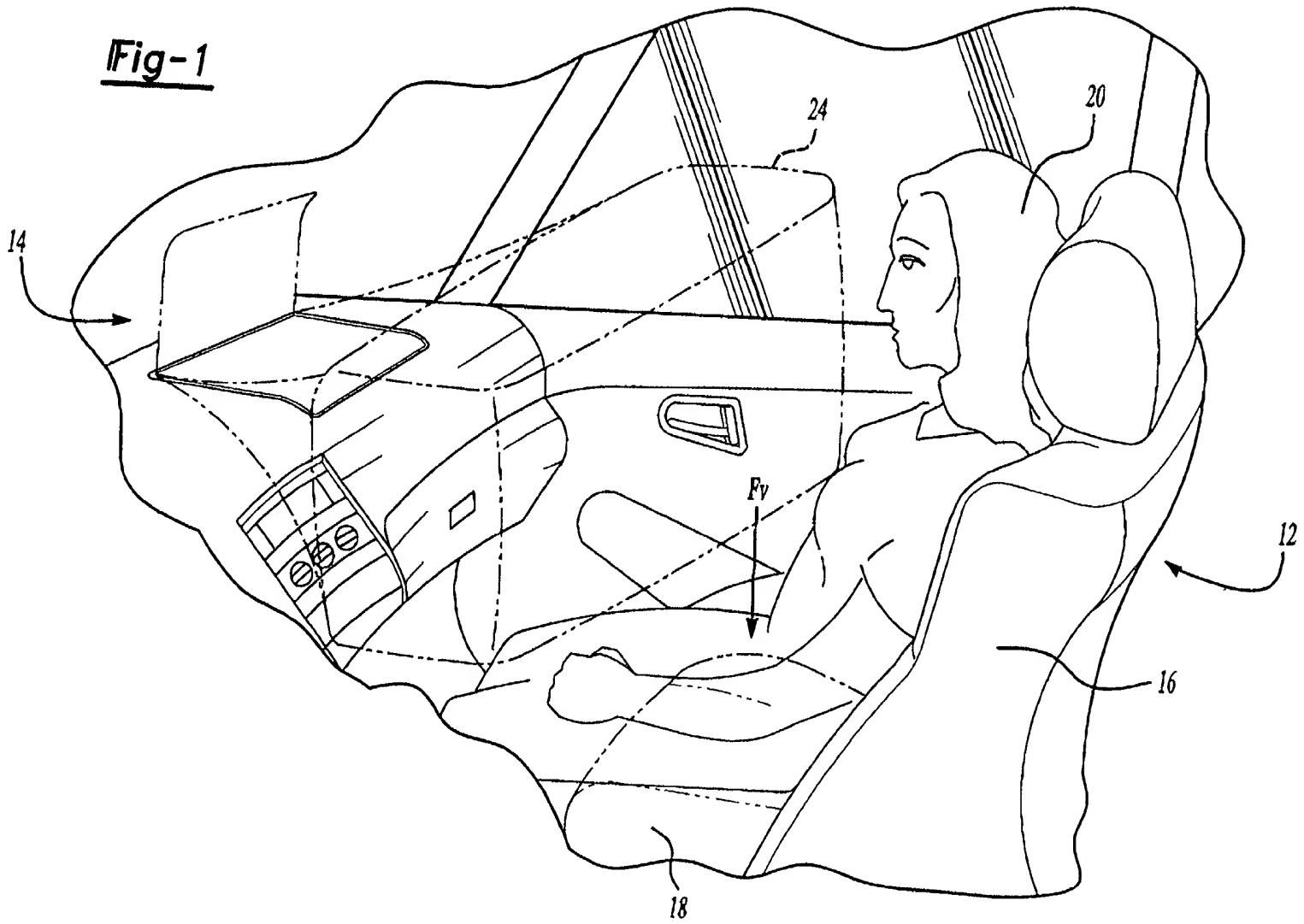
Fig-1



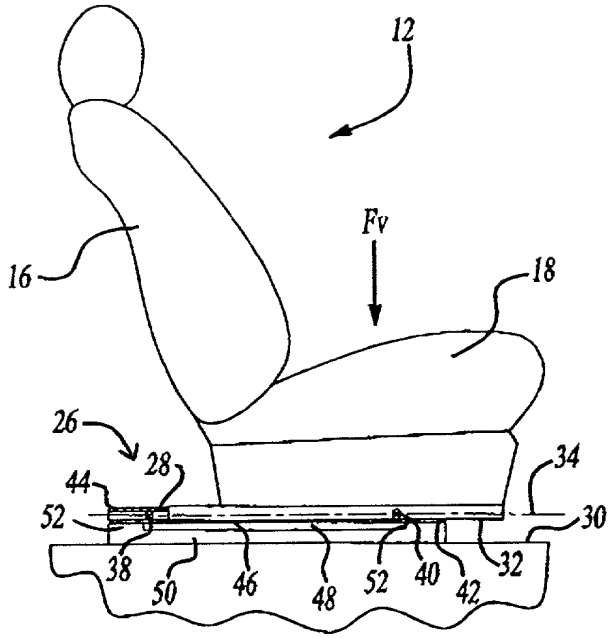


Fig-2

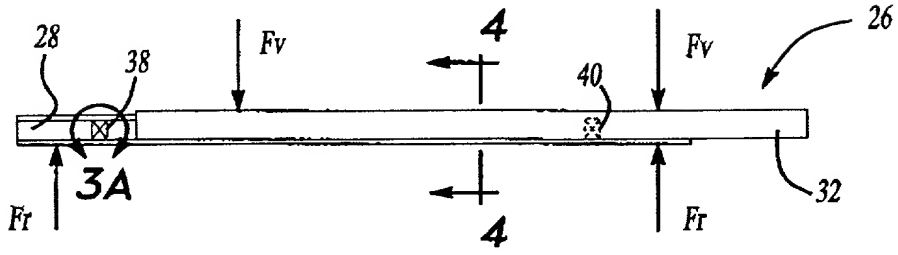


Fig-3

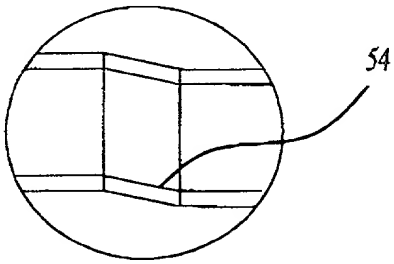


Fig-3A

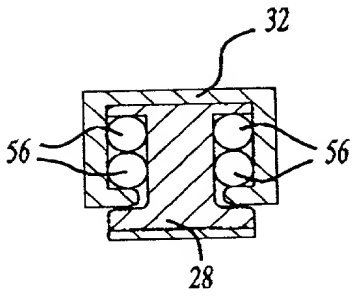


Fig-4

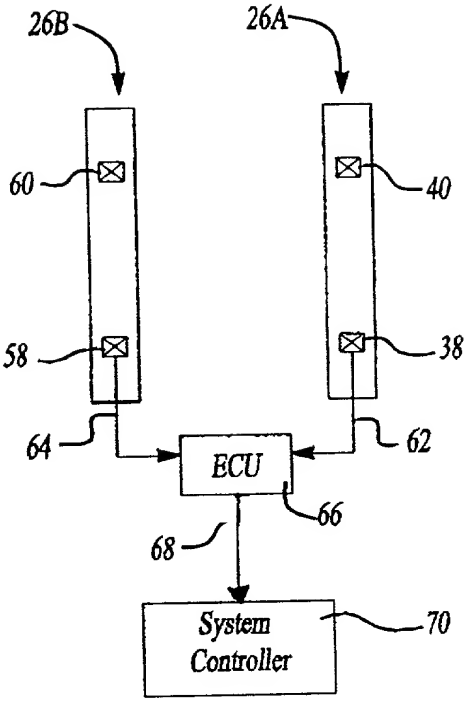


Fig-5

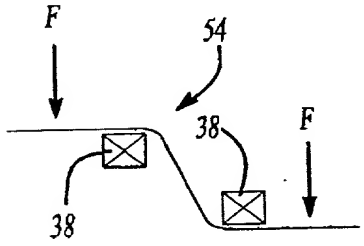


Fig-7

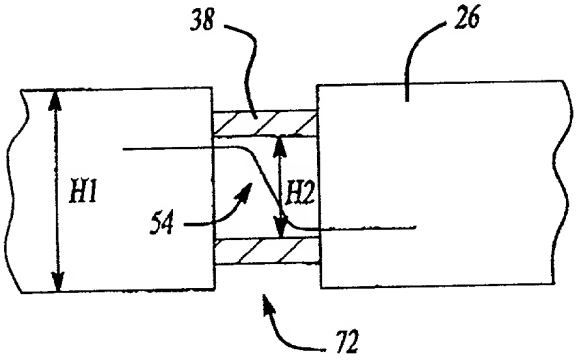


Fig-6

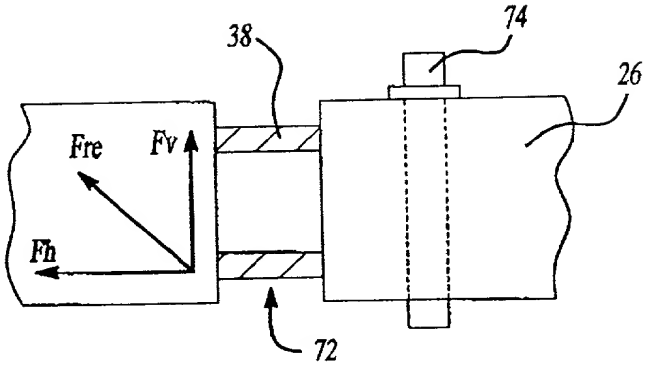


Fig-8

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)
99P7471USO1 claiming priority to 99P7471US filed February 24, 1999 Serial No.: 60/120,637		

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☐ Customer Number [ ] → Place Customer Number Bar Code Label here
OR
☒ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number
Laura M. Slenzak	35,363	Stanton C. Braden	32,556
Adel A. Ahmed	29,606	Robert T. Canavan	37,592
I. Marc Asperas	37,274	Joseph S. Codispoti	31,819

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☐ Customer Number or Bar Code Label [ ] OR ☒ Correspondence address below

Name	Laura M. Slenzak c/o Elsa Keller				
Address	Siemens Corporation				
Address	186 Wood Avenue South				
City	Iselin	State	NJ	ZIP	08830
Country	US	Telephone	248.253.2979	Fax	248.253.2996

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle (if any))	Family Name or Surname
Harald	Lichtinger

Inventor's Signature						Date	2/21/00
Residence: City	Auburn Hills	State	MI	Country	United States	Citizenship	German
Post Office Address	Beacon Hills Court, #308						
Post Office Address							
City		State		ZIP		Country	

☐ Additional inventors are being named on the ___ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page ___ of ___

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])		Family Name or Surname				
Ralf		Oestreicher				
Inventor's Signature					Date	2/21/00
Residence: City	Kandel	State		Country	Germany	Citizenship	German
Post Office Address	Robert-Koch-Strasse 25a, 76870 Kandel					
Post Office Address						
City		State		ZIP		Country	

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])		Family Name or Surname				
Josef		Dirmeyer				
Inventor's Signature					Date	2/21/00
Residence: City	Bodenwöhr	State		Country	Germany	Citizenship	German
Post Office Address	Waldstr. 9, 92439 Bodenwohr					
Post Office Address						
City		State		ZIP		Country	

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])		Family Name or Surname				
Inventor's Signature					Date	
Residence: City		State		Country		Citizenship	
Post Office Address						
Post Office Address						
City		State		ZIP		Country	

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Mark H. Jay	27,507	Eric C. Swanson	40,194
Rosa S. Kim	39,728		
Peter A. Luccarelli, Jr.	29,750		
Jeffrey P. Morris	25,307		
Donald B. Paschburg	33,753		
Darryl A. Smith	37,756		
Daniel J. Staudt	34,733		
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Scott T. Weingaertner	37,756		
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Ira Lee Zebrak	31,147		
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Harold W. Milton, Jr.	22,180		
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